Role of ARTIFICIAL GROUND-WATER RECHARGE in STREAMFLOW MANAGEMENT: PAST, PRESENT, and FUTURE

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Missoula, MT
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OVERVIEW

PAST: No artificial recharge; streamflow patterns were natural.

PRESENT (and recent past): Irrigation practices artificially recharge aquifers, which alters streamflow patterns.

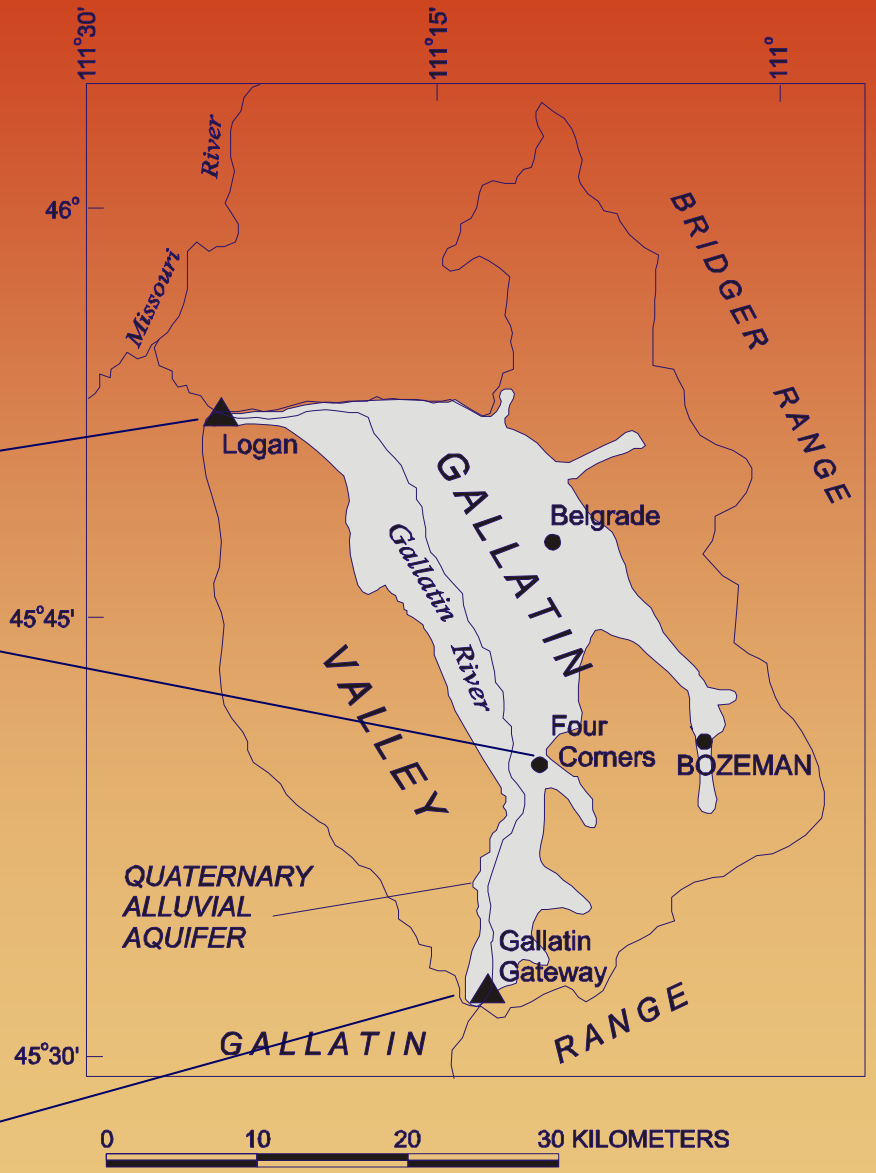
FUTURE: Land-use changes present opportunities to use artificial recharge to maintain existing conditions or to restore natural streamflow patterns.

Case study: Gallatin River, Montana

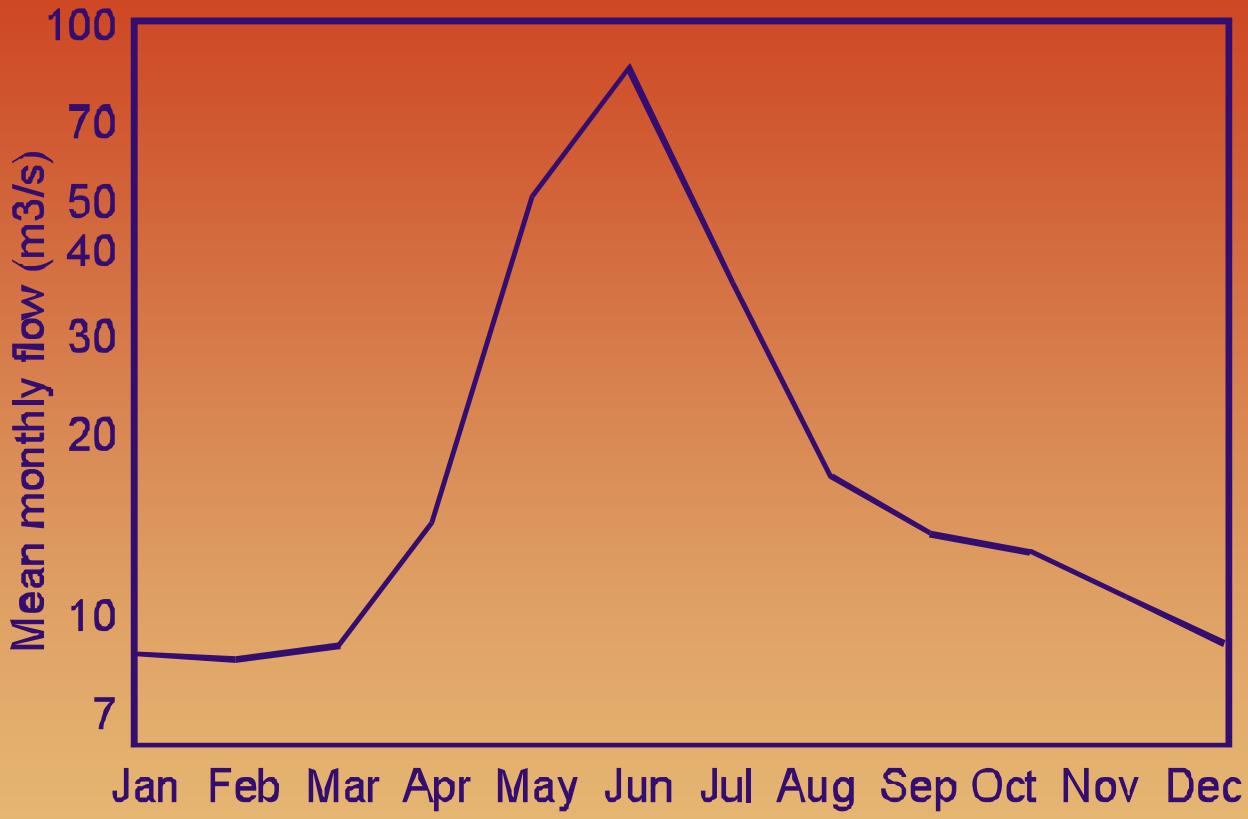
LOGAN

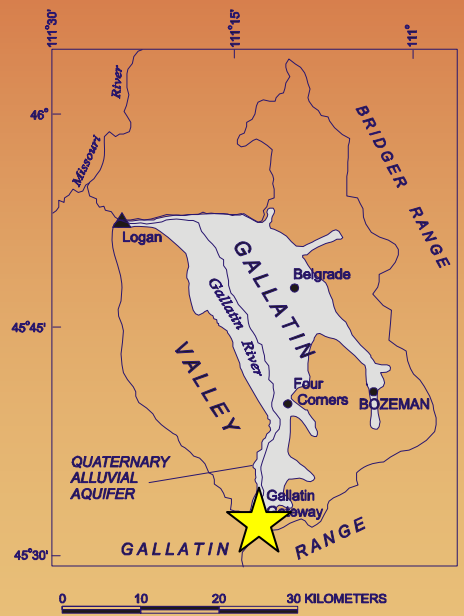
FOUR CORNERS

GALLATIN GATEWAY



The Past: Natural Streamflow Pattern

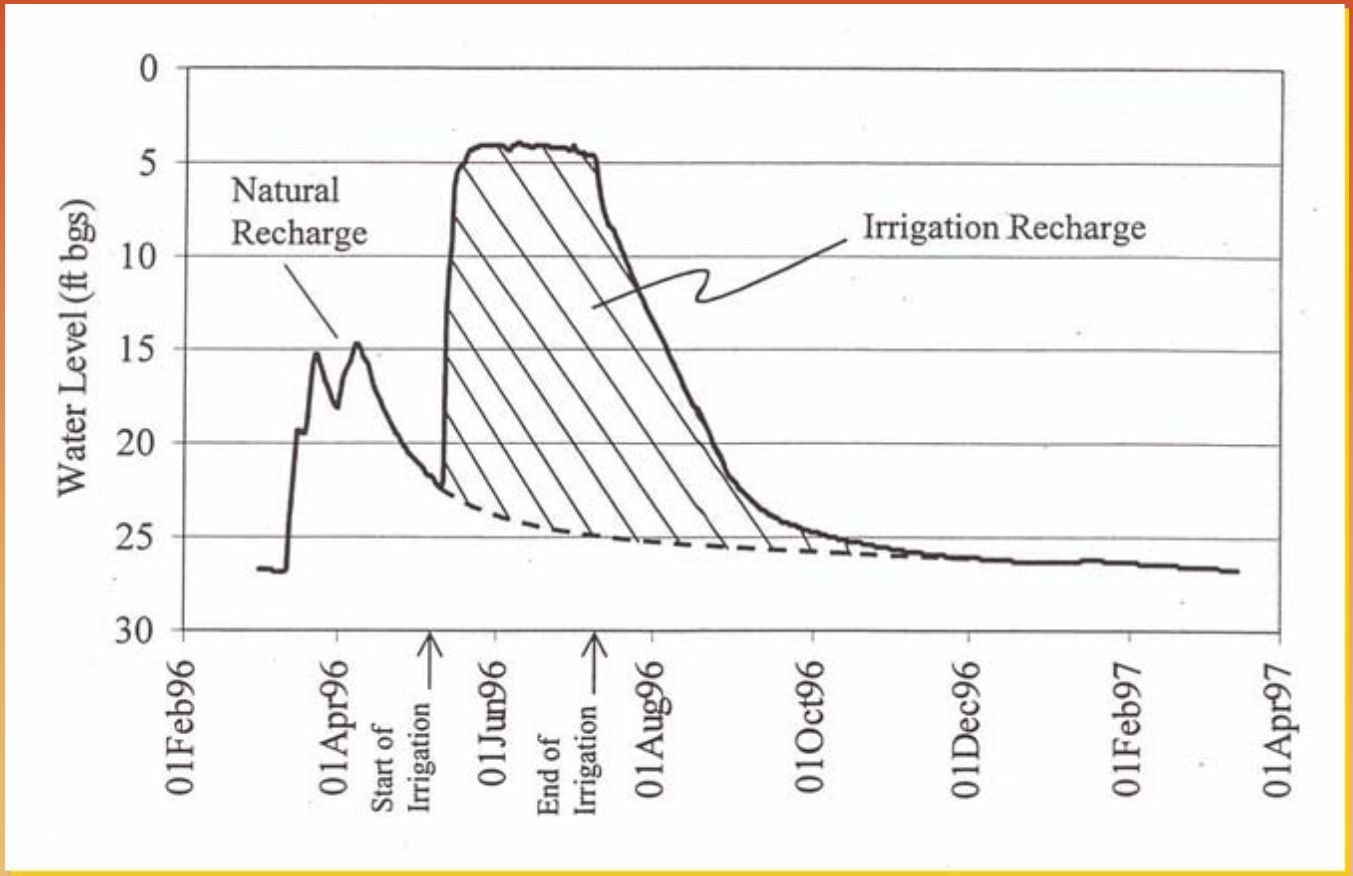




Average monthly flow of the Gallatin River at Gallatin Gateway

Kendy and Bredehoeft 2006

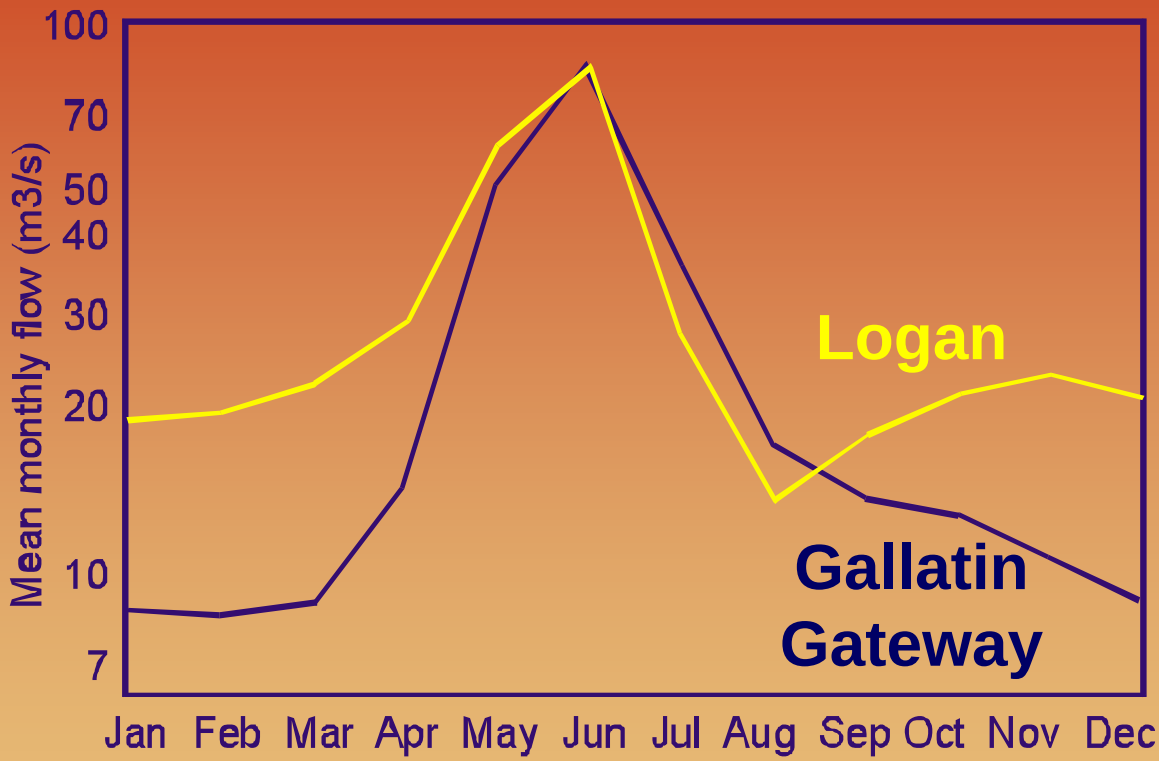
The Present: Excess Irrigation Water Artificially Recharges Ground Water

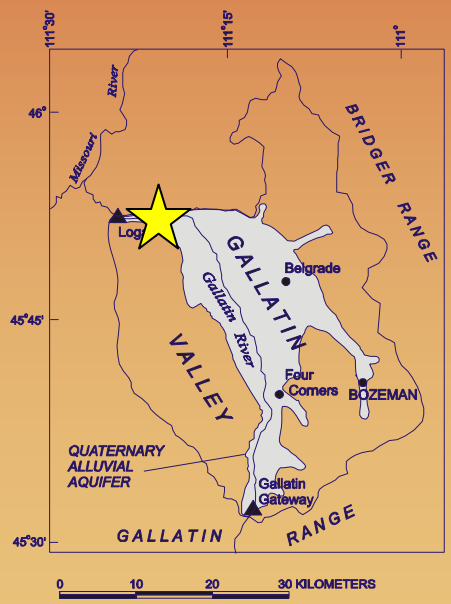


Seasonal water-table fluctuation, Upper Big Hole Basin

Marvin and Voeller, 2000, MBMG OFR 417

The Present: Streamflow under the Influence of Irrigation





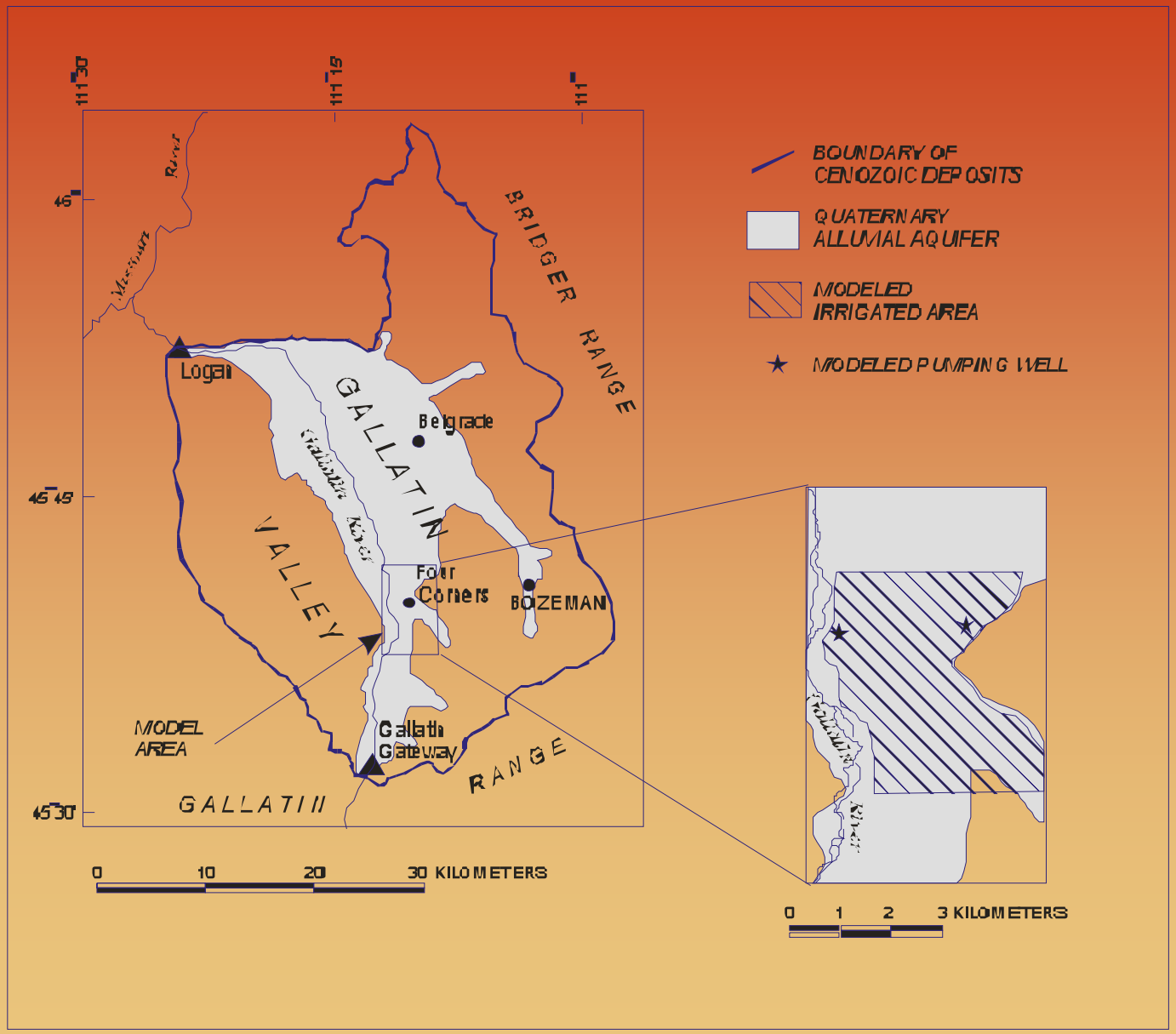
Average monthly flow of the Gallatin River at Logan

Kendy and Bredehoeft 2006

The Future: Irrigation Efficiency Improvements, Land-Use Change

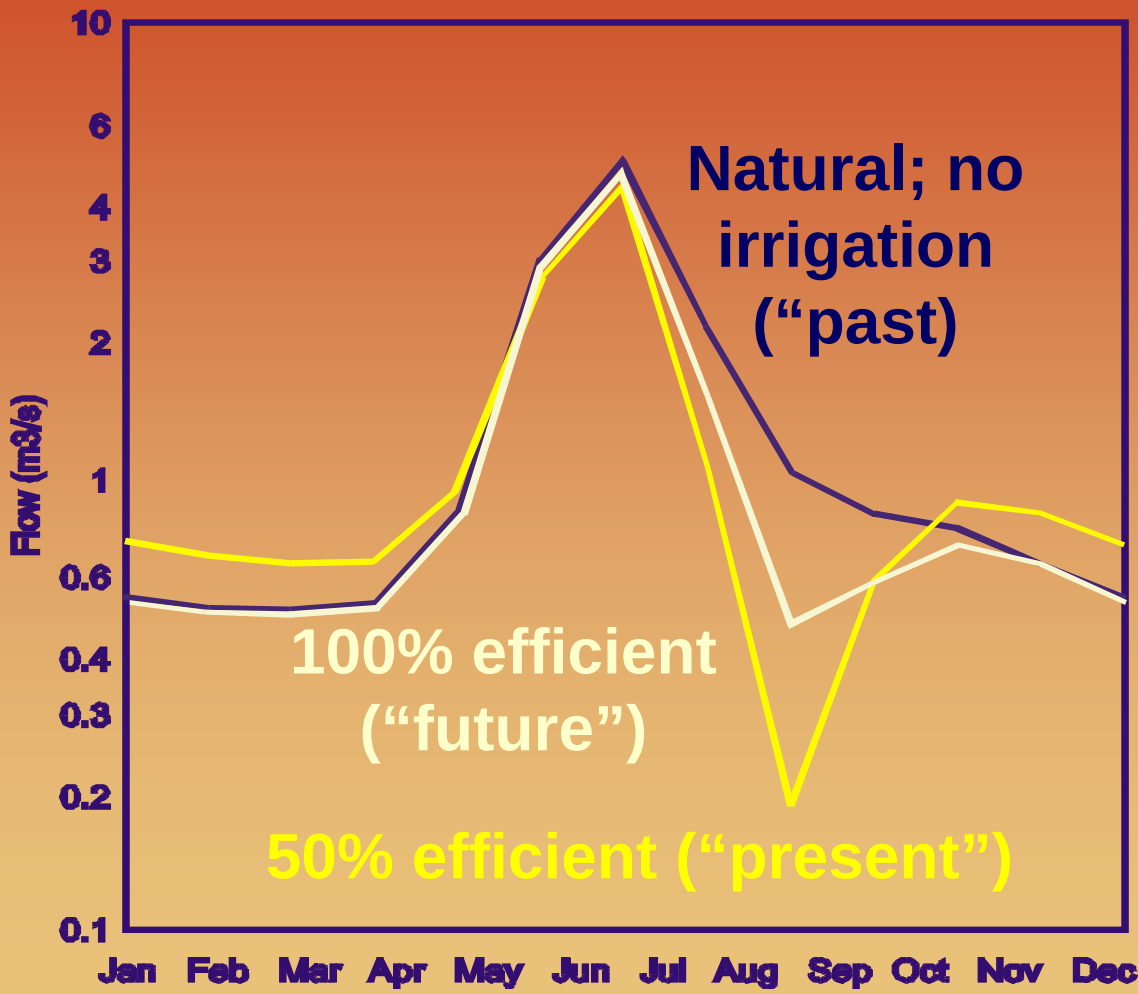
Photos: Mike Roberts, Hydrologist, Montana DNRC WRB;
http://www.parkcountyenvironmentalcouncil.org “Gallatin Gateway”

Ground-Water Model



Kendy and Bredehoeft 2006

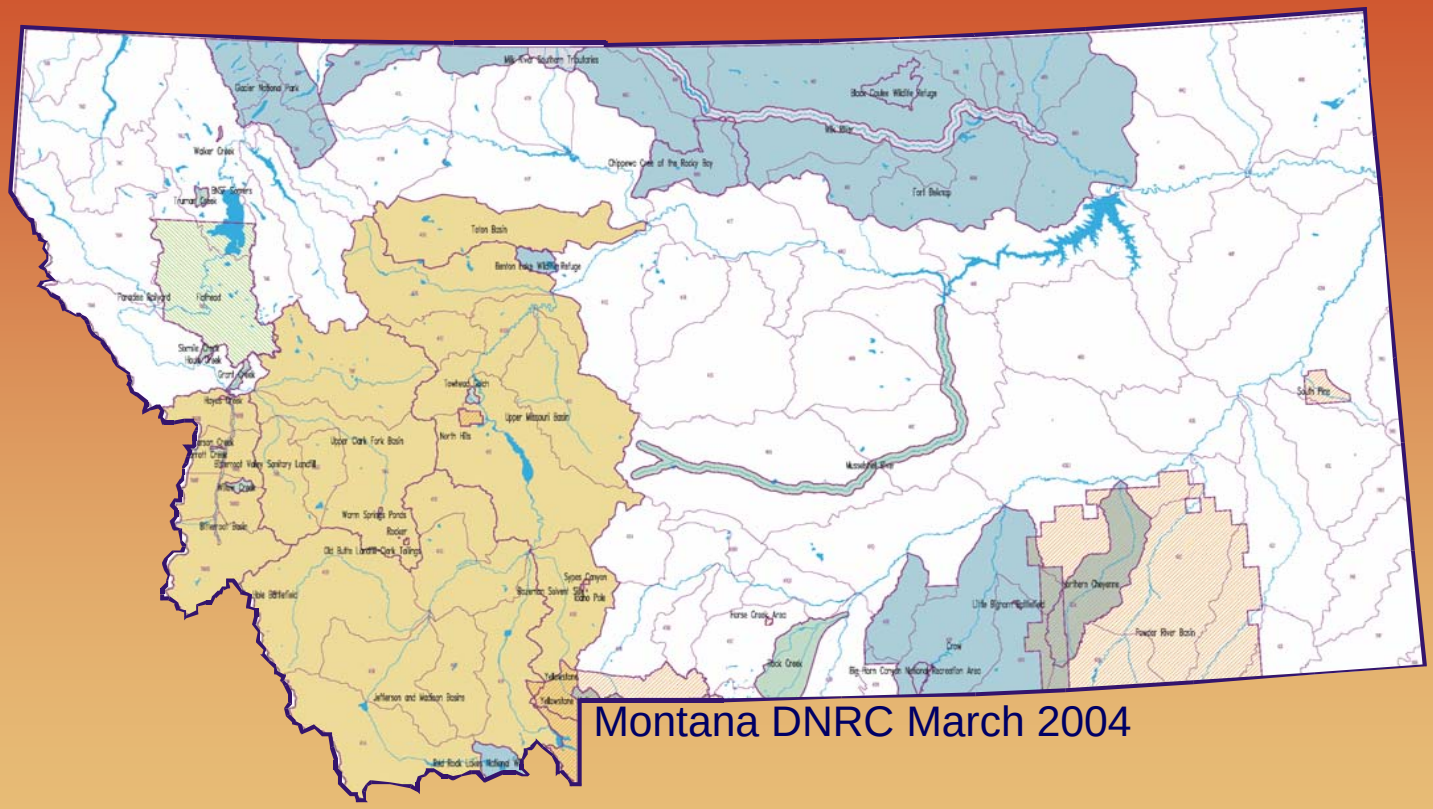
Impact of Irrigation Efficiency Improvement on Streamflow



Reducing artificial recharge increases summer flows, decreases fall and winter flows compared to present (unnatural) conditions.

Photo: Gallatin River at Cameron Bridge, running low due to irrigation. Bigskyfishing.com

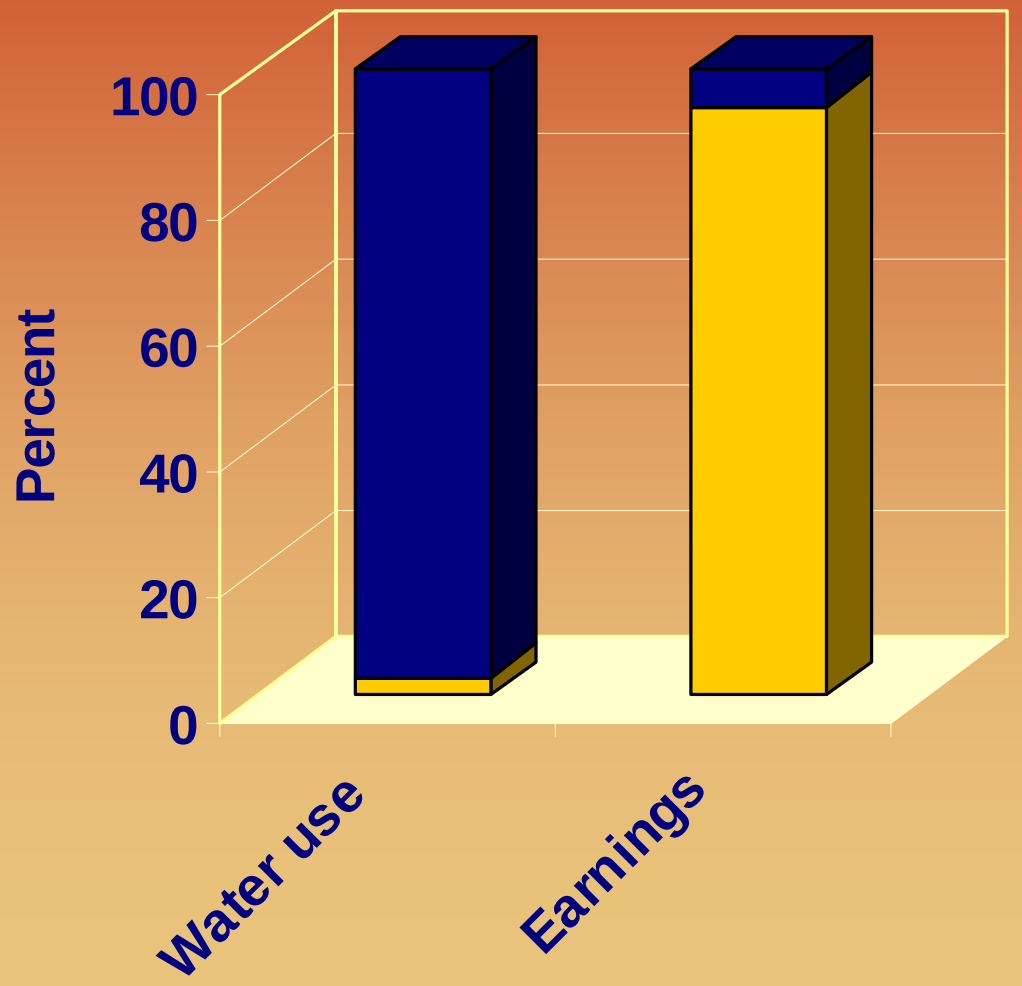
Future: Water-Right Changes in Closed Basins



Montana DNRC March 2004

- Controlled ground-water areas
- Montana Supreme Court order
- Dept. ordered Milk River closures
- Compact closures
- Legislative closures
- Administrative rule closures

Future: Water-Right Changes in Closed Basins



1990 WATER USE AND EARNINGS BY SECTOR IN MONTANA

- Agriculture
- Other

97/5.8

The Water Report, May 15, 2004

Augmentation:

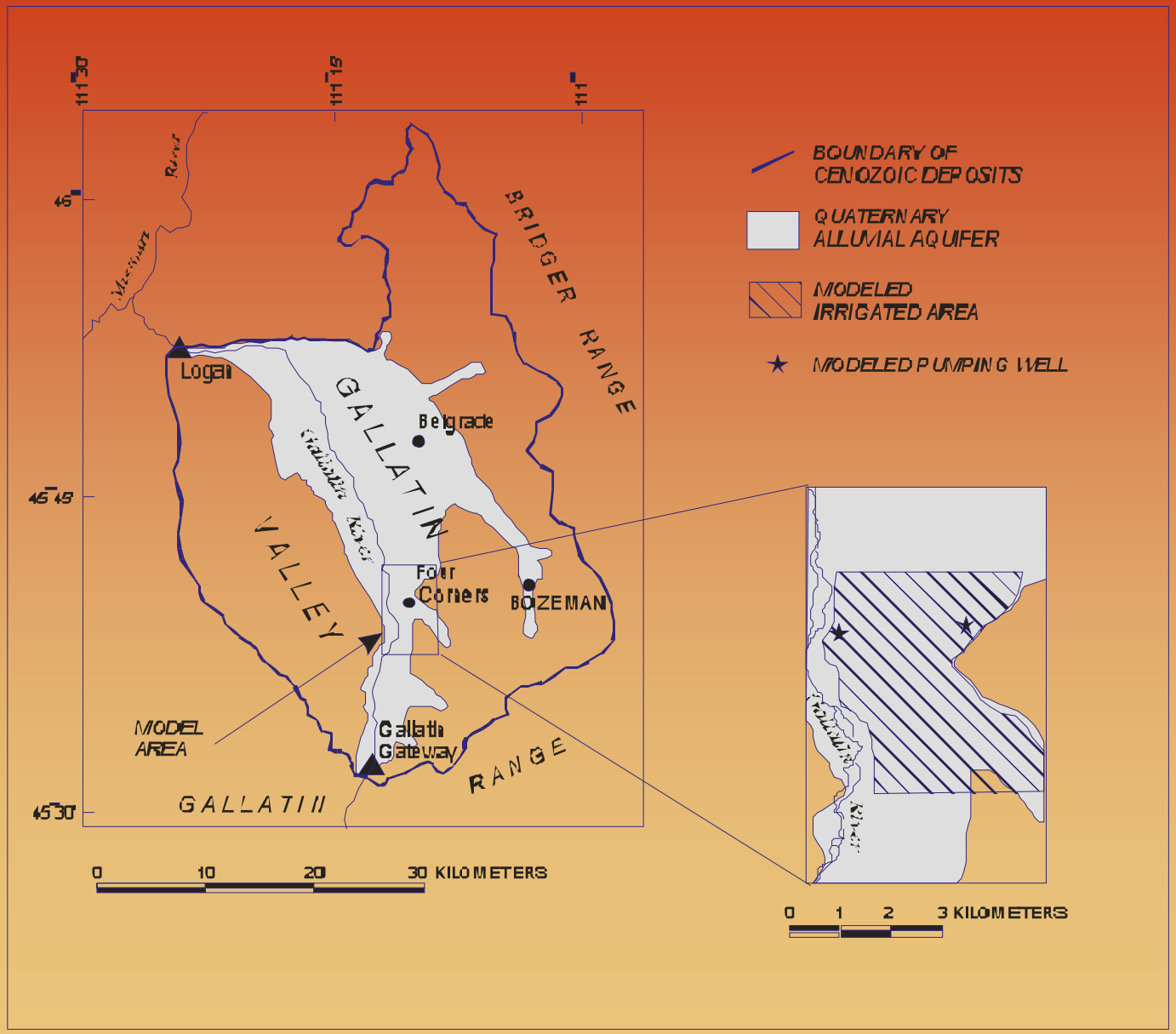
Conjunctive ground-water/surface-water management approach in which an existing diversion of surface water, with a water right, is retired to mitigate the stream depletion caused by new ground-water pumping.

Conserves the

- **Quantity**
- **Location**
- **Timing**

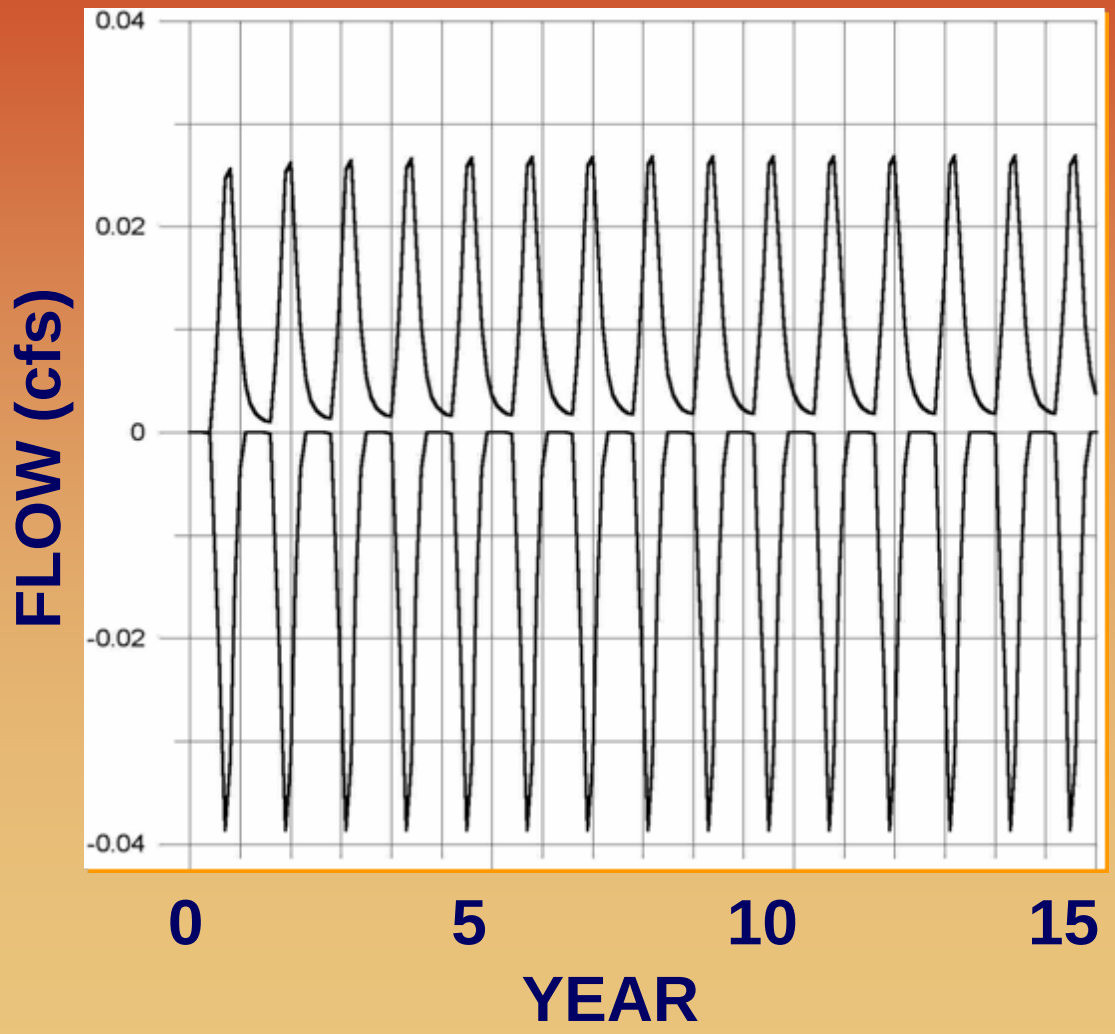
of ground-water discharge to surface water.

Ground-Water Model



Timing:
Impact of Pumping Near Surface Water

Streamflow depletion (top) is in phase with ground-water pumping (bottom).

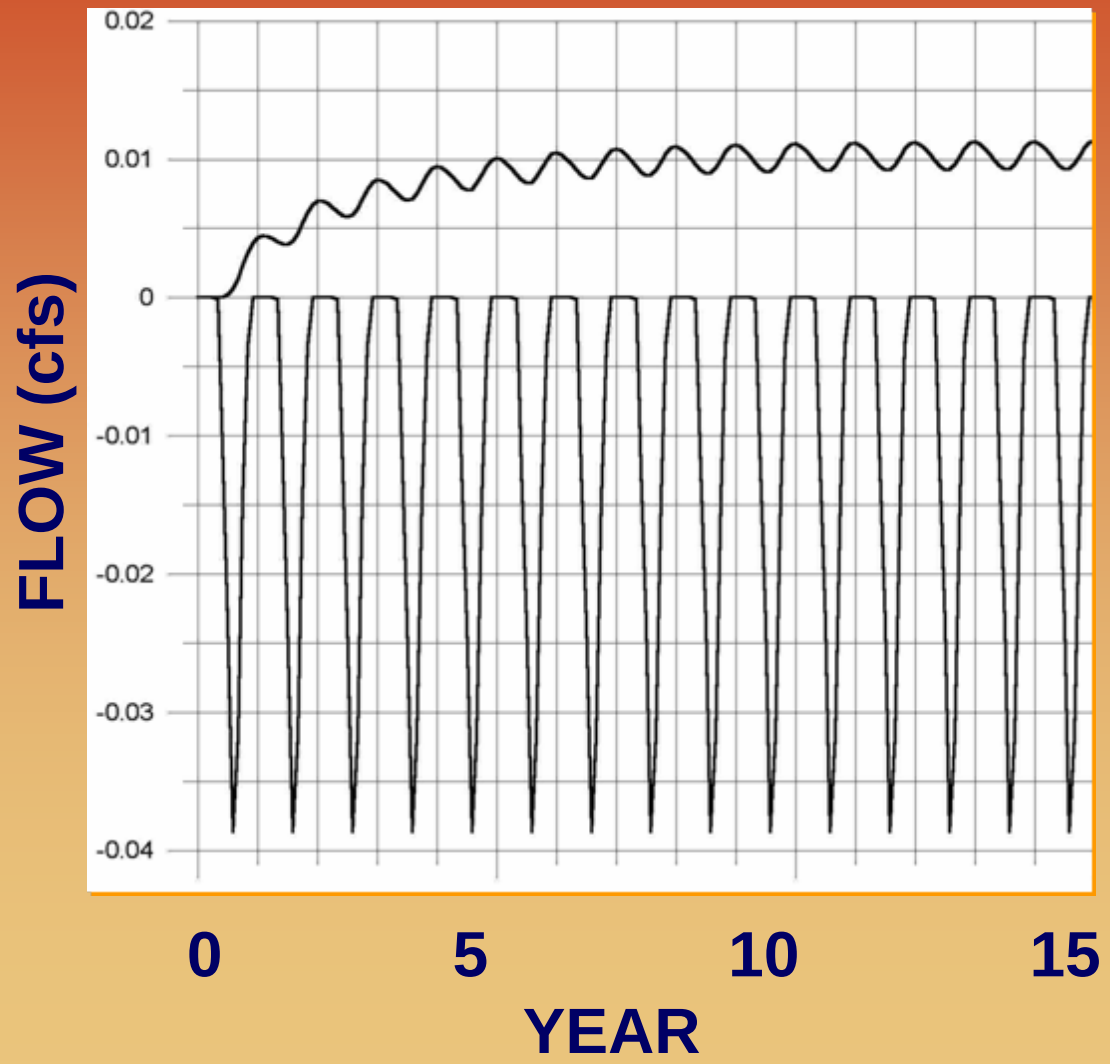


Timing:

Impact of Pumping Far from Surface Water

Streamflow depletion (top) takes more than eight years to peak and continues yearlong.

At peak, depletion = consumption.



The Future: Artificial Recharge as a Conjunctive Management Tool

Aquifer Storage and Recovery (ASR), Marco Lakes, FL
Water Resource Solutions, Inc.

Rapid infiltration basins, Orlando, FL

Recharge lagoon and municipal well, Dayton, OH

Policy Questions: Food for Thought

Manage water-use changes on a case-by-case basis?

or

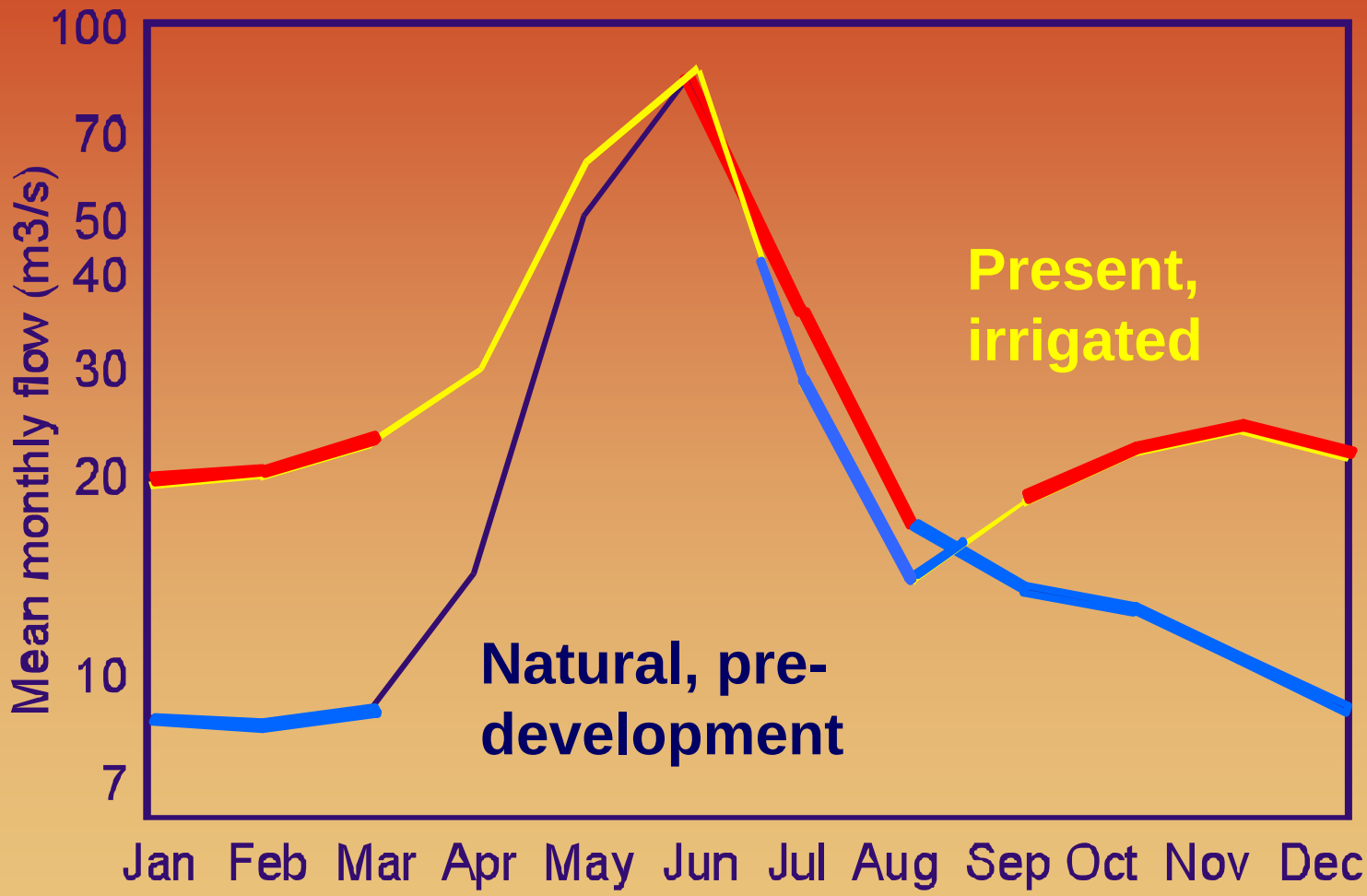
Develop basin-scale banking systems?

Maintain existing streamflow conditions?

or

Move toward restoring natural conditions?

Augmentation scheme depends on management goals



Summary: Role of Artificial Ground-Water Recharge in Streamflow Management

- **PAST: No artificial recharge; natural streamflows**
- **PRESENT (and recent past): Excess irrigation water artificially recharges aquifers; fall and winter streamflows are higher, summer streamflows are lower than under natural conditions**
- **FUTURE OPTIONS: Use artificial recharge either to maintain current streamflow conditions or to approach more natural, past conditions**

Kendy HYDROLOGIC CONSULTING

For Details…

Kendy, Eloise and Bredehoeft, John D., 2006, Transient effects of groundwater pumping and surface-water irrigation returns on streamflow: *Water Resources Research, vol. 42, no. 8.*

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